① $K = ?$ $\quad \underset{(0.075)}{1}H_2 + \underset{(0.075)}{1}Cl_2 \rightleftharpoons \underset{(0.95)}{2}HCl$

$$K = \frac{[HCl]^2}{[H_2][Cl_2]}$$

$$K = \frac{(0.95)^2}{(0.075)(0.075)} = \frac{0.903}{5.63\times10^{-3}} = 1.60\times10^{2}$$

$$\boxed{K = 160}$$

② $K = ?$ $\quad \underset{(0.13)}{1}N_2 + \underset{(0.13)}{1}O_2 \rightleftharpoons \underset{(0.19)}{2}NO$

$$K = \frac{[NO]^2}{[N_2][O_2]} = \frac{(0.19)^2}{(0.13)^2} = \frac{3.61\times10^{-2}}{1.69\times10^{-2}} = 2.14$$

$$\boxed{K = 2.14}$$

③ Concentrations

	$1H_2$	$+1I_2$	$\rightleftharpoons 2HI$
(R)			
(I)	0.750	0.750	$\emptyset$
(C)	$-x$	$-x$	$+2x$
(E)	$0.750-x$	$0.750-x$	$+2x$

$$K = \frac{[HI]^2}{[H_2][I_2]} = 54.3 = \frac{(2x)^2}{(0.750-x)^2} \Rightarrow 7.37 = \frac{2x}{0.75-x}$$

$$K = (7.37)(0.75-x) = 2x$$
$$(5.53) - (7.37x) = 2x$$
$$+7.37x \quad +7.37x$$
$$5.53 = 9.37x$$
$$\boxed{0.590 = x}$$

$H_2 = 0.750 - 0.590 = 0.160\,M$

$I_2 = \longrightarrow 0.160\,M$

$HI = 2(0.590) = 1.18\,M$

④ $[H_2], [I_2], [HI] = ?$

	H_2	+	I_2	$\rightleftharpoons$	$2HI$
R					
I	0.040		0.040		0
C	$-x$		$-x$		$+2x$
E	$0.040 - x$		$0.040 - x$		$2x$

$$K = \frac{[HI]^2}{[H_2][I_2]} = 54.3 = \frac{(2x)^2}{(0.040 - x)(0.040 - x)}$$

$$7.369 = \frac{2x}{0.040 - x} = (7.369)(0.040 - x) = 2x$$

$$0.295 - 7.369x = 2x$$
$$+7.369x \quad +7.369x$$
$$0.295 = 9.369x$$
$$3.146 \times 10^{-2} = x$$

$[H_2] = (4.0 \times 10^{-2}) - (3.146 \times 10^{-2}) = 8.54 \times 10^{-3}$ M

$[I_2] = \longrightarrow 8.54 \times 10^{-3}$ M

$[HI] = 2(3.146 \times 10^{-2}) = \longrightarrow 6.31 \times 10^{-2}$ M

(5) $[SO_2]$? $[NO_2]$? $[NO]$? $[SO_3]$?

	SO_2	+ NO_2	⇌ NO	+ SO_3	$K_c = 85.0$
(R) =	1	1	1	1	
(I) =	0.025	0.025	0.025	0.025	
(C) =	$-x$	$-x$	$+x$	$+x$	
(E) =	$0.025-x$	$0.025-x$	$0.025+x$	$0.025+x$	

$$K = \frac{[NO][SO_3]}{[SO_2][NO_2]} = 85.0 = \frac{(0.025+x)^2}{(0.025-x)^2}$$

$$9.22 = \frac{0.025+x}{0.025-x}$$

$$(9.22)(0.025-x) = 0.025+x$$

$$(0.231) - (9.22x) = 0.025 + x$$

$$+9.22x \quad +9.22x$$

$$0.231 = 0.025 + 10.22x$$

$$-0.025 \quad -0.025$$

$$0.206 = 10.22x$$

$$2.016\times10^{-2} = x$$

$[SO_2] = (2.5\times10^{-2}) - (2.02\times10^{-2}) = 4.80\times10^{-3}\ M$

$[NO_2] = \longrightarrow 4.8\times10^{-3}\ M$

$[NO] = (2.5\times10^{-2}) + (2.02\times10^{-2} = 4.52\times10^{-2}\ M$

$[SO_3] = \longrightarrow 4.52\times10^{-2}\ M$

⑥ $[N_2], [O_2], [NO] = ?$ $\quad K = 85.0$

concentrations:

$[NO]_0 = \frac{0.185 \text{ mol}}{6 \text{ L}} = 3.08 \times 10^{-2} = [O_2]_0 = [NO]_0$

	$2\,NO$	$\rightleftharpoons$	$1\,N_2$	+	$1\,O_2$
I	3.08×10^{-2}		3.08×10^{-2}		3.08×10^{-2}
C	$-2x$		$+x$		$+x$
E	$3.08\times10^{-2}-2x$		$3.08\times10^{-2}+x$		$3.08\times10^{-2}+x$

$$K = \frac{[N_2][O_2]}{[NO]^2} = 85.0 = \frac{(3.08\times10^{-2}+x)^2}{(3.08\times10^{-2}-x)^2} \Rightarrow 9.22 = \frac{3.08\times10^{-2}+x}{3.08\times10^{-2}-x}$$

$$K = (9.22)(3.08\times10^{-2}-x) = 3.08\times10^{-2}+x$$

$$K = (2.84\times10^{-1}) - (9.22x) = 3.08\times10^{-2}+x$$

$$-3.08\times10^{-2} \quad +9.22x \quad -3.08\times10^{-2} \quad +9.22x$$

$$K = -2.53\times10^{-1} = 10.22x$$

$$\boxed{2.48\times10^{-2} = x}$$

$[NO] = (2)(2.48\times10^{-2}) \longrightarrow = 4.96\ \underline{M}$

$[N_2] = [O_2] = (3.08\times10^{-2}) - (2.48\times10^{-2}) = 6.00\times10^{-3}\ \underline{M}$

(7)

	HSO_4^-	$\rightleftharpoons$	H^+	+	SO_4^{2-}	$K = 0.012$
(R)						
(I)	0.500		$\emptyset$		$\emptyset$	
(C)	$-x$		$+x$		$+x$	
(E)	$0.500 - x$		x		x	

$$K = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]} = 0.012 = \frac{(x)(x)}{0.500 - x}$$

$$0.012 = \frac{x^2}{0.500 - x}$$

(1) You can solve this using the quadratic equation
(2) or you solve it by using the "5% rule".

Reasoning: 5% rule — Because K is small, we can assume that the amount lost ("$-x$") is small compared with [reactant]$_0$. In other words:

$$0.500 - x \approx 0.500$$

Therefore:

$$0.012 = \frac{x^2}{0.500}$$

$$0.024 = x^2$$

$$7.75 \times 10^{-2} = x$$

$[HSO_4^-] = 0.500 - 7.55 \times 10^{-2} = 0.423\ M$

$[H^+] = x \longrightarrow = 7.55 \times 10^{-2}\ M$

$[SO_4^{2-}] = x \longrightarrow = 7.55 \times 10^{-2}\ M$

* 5% rule: when $\frac{x}{[\text{reactants}]} < 5\%$, $[\text{reactant}] - x \approx [\text{reactant}]$

(5% rule works b/c measurement are generally ±5% for concents)